Radiation-induced thumbs carcinoma due to practicing dental X-ray

Esam S. Halboub, Imad Barngkgei[1], Osama Alsabbagh[1], Omar Hamadah[1]

Abstract

Dealing with diagnostic X-ray radiation may result in serious health problems, unless protection guidelines are followed. This became prevalent immediately a decade following the invention of X-ray radiation, where it had not been known that the accumulative exposure to X-ray radiation may carry huge health hazards. The reoccurrence of various fatal cancer cases compelled the concerned health authorities to develop safety standards to be followed by all X-ray clinics and technicians worldwide. This report documents the clinical case of a dental radiographer, who developed thumbs carcinoma after 15 years of practicing the profession, most likely due to his neglect of the X-ray radiation protection guidelines.

Keywords: Dental radiography, squamous cell carcinoma, thumb

Introduction

During the early years that followed the discovery of X-ray, radiographers were unintentionally, incautious when dealing with it because of its unknown biological harmful effects.[1]

Many cases of cancer, sterility and death due to X-ray/radiation toxicity were documented during the early years of the 20th century. For example, in 1907, 6 out of 11 cases with X-ray-induced caners died.[2] Moreover, many early workers in the field of dentistry suffered from radiation-induced ulceration, dermatitis and malignant tumors in their fingers.[3-5] With strict compliance to the radiation protection guidelines, issued by the International Commission on Radiological Protection (ICRP), diagnostic radiography is considered a safe practice. Apart from the report by Hashizume *et al*.,[6] no other reports addressing the disastrous effects of X-ray radiation have been documented in the literature since 1960s. The present report, however, documents a case of thumbs carcinoma of a dental radiographer due to his neglect of radiation protection guidelines.

Department of Oral Medicine and Periodontology, Faculty of Dentistry, Sana'a University, Sana'a, Yemen, [1]Department of Oral Medicine, Faculty of Dentistry, Damascus University, Damascus, Syria

Correspondence: Dr. Imad Barngkgei,
Department of Oral Medicine, Faculty of Dentistry, Damascus University, Damascus, Syria.
E-mail: imadbarn@gmail.com

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Case Report

In August 2010, a 49-year-old male working as a dental radiographer, lost his distal phalanges of both thumbs as a result of development of squamous cell carcinoma, due to neglect of the guidelines of protection related to X-ray imaging.

He was appointed in 1994 by the Radiology Division, primarily as an in-charge clerk within the Oral Medicine Department (Faculty of Dentistry, Damascus University). As a school graduate with an intermediate certificate, his main task was merely to monitor the radiographic equipment.

Given that there was only one radiographic technician at that time, it was decided in 1995 to train him on how to use the dental X-ray machines and how to radiograph patients. He was warned about the radiation risks and thoroughly educated on the appropriate protection standards. He was somewhat committed to wearing the lead apron and the dosimeter. On the other hand, he was accustomed to handling the periapical films with his thumb fingers.

In 2003, he noticed a very small ulcer at the tip of his right thumb. Although it was asymptomatic, he considered it as a traumatic ulcer and hence willingly neglected it for a period, which under normal circumstances would be considerably enough for such an ulcer to heal. Subsequently he then experimented with various courses of local and systemic antibiotic, but the ulcer did not show any signs of healing. Based on his judgment, it was asymptomatic and unprogressive, and accordingly he perceived to be a normal exfoliation, the result of his long-term handling of chemical processing solutions.

In August 2010 (after 15 years of handling dental X-ray), he noticed a discharge oozing from his right thumb. By that time, he also took notice of a similar ulcer in his left thumb. He consulted the professors in the department who in turn referred him to a general surgeon. On plane hand radiographs,

Figure 1: Plane hand radiograph reveals bone erosion in the right thumbs' distal phalanges

Figure 2: Plane hand radiograph reveals bone erosion in the left thumbs' distal phalanges

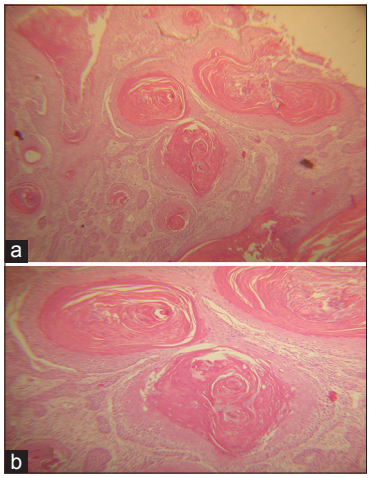

Figure 3: Histopathologic microphotographs reveal squamous cell carcinoma ([a] ×40 and [b] ×100)

Figure 4: Postoperative view

an erosion of the distal phalanges of both thumbs was clearly evident [Figures 1 and 2]. Consequently, the surgeon planned to excise the discharging ulcerative lesion of the right thumb and to submit it for histopathological diagnosis, which clearly revealed squamous cell carcinoma Grade II [Figure 3]. Based on such a diagnosis, the surgeon decided to excise the distal phalanges of both thumbs with tumor free-margins [Figure 4]. Out of ethical consideration, the radiographer was well-informed about the intent to publish his case and hereby he signed an informed consent.

Discussion

Early X-ray machines needed to be set and repeatedly adjusted. To achieve this, radiographers would place their hands between the actively radiating tube and the film plate to check if the apparatus was functioning and that it was well focused on the film. By practicing this for 12 years, Dr. Kells was the first victim of dental X-ray radiation with numerous cancerous tumors on his fingers.[1] By that time, the ICRP published guidelines for radiation protection that have been updated from time to time. In Syria, the Atomic Energy Commission adopted these guidelines and has since strictly emphasized the importance of their application by public and private institutions. One of the guidelines clearly states that the film should never be hand held by a member of the dental practice staff, even for patients with special needs.

Holding periapical films in the patient's mouth is still practiced in modern dentistry, but, fortunately, is not common. Sixty per cent of Australian dentists never do this, but 25% will do so less than once every month, and 1.5% might do so more than 10 times a month.[7]

The radiation-risk is the function of the radiation dose which is expressed as an effective dose. The National Commission for Radiation Protection in the United States reports that the mean effective dose received by dental workers is 0.2 mSv/year.[8] Similarly, the National Radiological Protection Board,[9] in the UK estimates a mean level

of < 0.1 mSv/year. In dose limit terms for workers, the current effective dose limit is 100 mSv in any consecutive 5 years with a maximum of 50 mSv in any year. These limits are based on guidance from the ICRP,[10] with the effective dose limit being set at a level at which the stochastic risk is considered to be at the limit of acceptability. The probability of radiation-induced stochastic effects for the whole population is 7.3×10^{-2}/Sv.[11]

The working load in the Radiology Division within the faculty ranges between 100 and 150 patients a day. Hence, the radiographer in the current report received a fraction of about 600–900 μSv/day; 13.2–19.8 mSv/month; 158–237 mSv/year and 2.4–3.6 Sv in 15 years. Therefore, he exceeded the maximum annual dose limit allowed by 3.2–4.7 times. Overall, he was at a greater risk of getting a stochastic effect by 2.4–3.6 times compared to the whole population, as the probability of radiation-induced stochastic effect for this case ranges from 18×10^{-2} to 26×10^{-2}/Sv.

Some authorities claim that any dose of radiation has the potential to induce malignant changes, and there is no threshold dose below which radiation is predictably safe.[12] The risk of induction of fatal cancer or serious hereditary ill-health from dental intra-oral radiography was estimated to be 1 in 10 million (10^{-7}) per exposure.[12] The radiographer in this case conducted 396,000–594,000 exposures in 15 years. This increased the risk of inducing fatal cancer or serious hereditary ill-health to 4–6 in 100 (10^{-2}). However, the risk-estimates depend on the shape and length of the collimator or position indicating devices (PIDs).[12,13]

The short and pointed cones with closed-end, such as that which had been used by the radiographer in this report for 13 years (Fiad, DR 554, Italy), have the greatest probability of a stochastic effect (1 in 26×10^{-6}) in comparison to the rectangular or round ones. The latter, which are open-ended and have been used for the last 2 years of the radiographer's work (Ardet s.r.l Buccinasco [MI] Orix 70, Italy), have a probability of a stochastic effect ranging from 1 in 4.6×10^{-6} to 1 in 23×10^{-6} according to the length.[13] The short and pointed PIDs tend to scatter the beam.[14] Overall, the shielded open-end PIDs, both round and rectangular in shape, have become more widely used during the past 40 years because of the reported decrease in patient exposure that is achieved.[15,16]

In general, dental radiography has a little dose and risk for the individual patient and dental workers provided that the principles of protection are applied; it is less dangerous in comparison to a few days of natural background radiation to which we are all constantly exposed.[12]

Dental radiography doses and risks are minimal unless dealt without being cautious, which is the case of the radiographer presented here.

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